

Lower Wilson Creek, Caldwell County, North Carolina: A Thermal Refugium for Reptiles?

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ABSTRACT.— Fourteen species of reptiles were found in a year-long study of lower Wilson Creek, Caldwell County, North Carolina. Of these, four—*Anolis carolinensis*, *Scincella laterale*, *Eumeces inexpectatus*, and *Tantilla coronata*—represented significant range extensions into the northwestern mountains of the state. Climatological studies in the area revealed a relatively equable temperature regime, with lower daytime highs and higher daytime and winter lows than nearby Lenoir. A combination of exposed rock for basking, deep fissures, and warmer night and winter temperatures is probably responsible for the continued presence of these species well outside their heretofore known ranges. These populations may represent relicts dating from late in the Hypsithermal Interval, approximately 7000 years ago.

INTRODUCTION

Wilson Creek and its tributaries drain most of the southeastern slope of Grandfather Mountain in Avery, Burke and Caldwell counties, North Carolina. These streams descend steeply from over 1220 m (4000') to about 330 m (1080') where Wilson Creek flows into the Johns River on its way to the Catawba River. Wilson Creek is one of the more rugged and scenic streams of the eastern Blue Ridge front, with waterfalls and rapids in the main gorge. The discovery of several green anoles, *Anolis carolinensis* Voigt, in the lower part of the Wilson Creek gorge in August 1980 indicated that this area might also harbor other species normally found only in lower, warmer parts of North Carolina. We therefore set out to determine which species of reptiles occur in the area, whether they represent natural populations, and what aspects of the area are responsible for maintaining the reptile community.

MATERIALS AND METHODS

The study was carried out in the gorge of lower Wilson Creek approximately 18 km (11 mi) west of Lenoir. The site was in the Pisgah National Forest and included the riparian zone along Wilson Creek and the steep, northeastern side of the gorge up to about 765 m (2510') on

the southern and western slopes of Adams Mountain and the western slope of Loose Mountain (USGS Collettsville 7.5' topographic map). The site was centered near 81°44'W 35°36'N along county road 1328 three to five km north of county road 1337 and about 2.5 km north of Brown Mountain Beach resort.

In this area, Wilson Creek cuts a gorge that drops off from about 700 m (2300') to the streambed at 365 m (1200'). The northeastern side of the gorge, which includes the study area, consists of steep, rugged slopes with exposed granite bedrock interdigitating with woods dominated by stunted oaks (*Quercus* spp.), maples (*Acer* spp.), sweet gum (*Liquidambar*), and Virginia pines (*Pinus virginiana*). Occasional small patches of vegetation are isolated in extensive areas of bare rock. Deep crevices and fissures are common throughout the area and abundant in the streambed.

The site was searched for reptiles several times in August 1980 and weekly from September 1, 1980 until March 15, 1981. Sporadic visits were then made through August 1981. Thirty-six site visits were made, and over ninety hours were spent searching for reptiles. During warmer periods visual searches for active animals were supplemented by turning rocks and logs. Winter searches were mostly visual searches of the fissured granite along the creek. Species and activity were recorded whenever a reptile was encountered. Voucher specimens of most species were deposited in the vertebrate collection at Appalachian State University.

In order to learn more about the local environment and to determine whether it was unique in any way, temperature and rainfall data were obtained for the Wilson Creek area and compared with similar data for comparable elevations at nearby Lenoir (U. S. Weather Service). A thermograph was placed at Brown Mountain Beach resort on September 1, 1980 and checked weekly until March 15, 1981. Data were recorded for 186 days when the thermograph functioned properly. Rainfall data for Wilson Creek consisted of fifteen years of data from Mortimer, a short distance upstream from the study area (U. S. Forest Service environmental statement for the Wilson Creek area, pers. comm., Mr. Pat Cook, District Ranger). Lenoir was chosen for comparison because of its proximity and because Nicoletto's experience in the area indicated that none of the unusual species occurred there.

Since temperature, in its various guises, potentially limits reptile distributions, daily maximum and minimum temperatures at Wilson Creek were used separately as independent variables in linear regressions against paired Lenoir data (MINITAB computer program package; Ryan et al. 1976). These regressions and long term data for Lenoir (49 years, U. S. Weather Service) were used to estimate mean monthly minimum temperatures at Wilson Creek. Monthly and annual rainfall

data at the two sites were compared with paired *t*-tests. Statistical sources were Sokal and Rohlf (1969) and Rohlf and Sokal (1969). Significance levels of $P < 0.05$ and $P < 0.01$ are indicated throughout this paper by one (*) and two (**) asterisks, respectively.

RESULTS

Fourteen species of reptiles were found at the study site (Table 1). Local residents also reported that rattlesnakes, *Crotalus horridus* Linnaeus, were occasionally seen in the area. A medium-sized black snake seen but not captured was probably a black rat snake, *Elaphe obsoleta* (Say). Most species found along Wilson Creek are those to be expected in the mountains, but four species represent significant range extensions into this part of North Carolina of forms that are usually in lower, warmer areas. These species are the anole; the ground skink, *Scincella laterale* (Say); the southeastern five-lined skink, *Eumeces inexpectatus* Taylor; and the southeastern crowned snake, *Tantilla coronata* Baird and Girard.

Lower Wilson Creek is apparently an unusual microclimate in the mountains. It is wetter and warmer than the Lenoir area, where the unusual species do not occur. Annual precipitation averaged 136.9 cm (53.9 in) at Wilson Creek and 125.3 cm (49.3 in) at Lenoir. In matched data for 15 years prior to 1980, annual and monthly averages were higher at Wilson Creek (**), with differences of 0.23 to 1.7 cm (0.09-0.67 in).

Figure 1 shows the relationship between daily minimum temperatures at Wilson Creek and Lenoir. The regression is highly significant (**) and indicates not only that Wilson Creek is warmer but also that the magnitude of the difference is greatest when the temperature is lowest. At 0° C in Lenoir, Wilson Creek should be about 3.8° C. Wilson Creek was cooler than Lenoir on only six of the 186 days (**, sign test). Daily maximum temperatures at the sites are presented in figure 2. The regression is highly significant (**), and the two sites are rather different. Wilson Creek had lower maximum temperatures 169 of 178 days (**, sign test). There is about 2° C difference between the sites at 0° C in Lenoir, but this difference gets larger as do maximum temperatures. Daily temperature ranges are narrower at Wilson Creek than at Lenoir. Monthly means of minimum daily temperature at Lenoir (49 years) and estimates for Wilson Creek are presented in figure 3. Wilson Creek is generally warmer and does not have a month with a mean low temperature below freezing; even in winter there are numerous warmer days. Coldest temperatures recorded during the study were -12° C (10° F) at Wilson Creek and -15° C (5° F) at Lenoir.

Table 1. Reptiles found at the Wilson Creek site in Caldwell County, North Carolina, 1980 and 1981. Species represented by voucher specimens in the collection at Appalachian State University are indicated by dagger (†). Elevations determined by altimeter.

Species	# Seen	Elev. (m)	Last Date	First Date
† <i>Anolis carolinensis</i> Voigt	15	378-500	4 Nov.	8 Mar.
† <i>Sceloporus undulatus</i> (Latreille)	100	366-506	25 Nov.	8 Mar.
† <i>Eumeces fasciatus</i> (Linnaeus)	ca. 20	366-494	---	13 Mar.
† <i>Eumeces inexpectatus</i> Taylor	5	366-457	7 Oct.	13 Mar.
† <i>Eumeces laticeps</i> (Schneider)	2	363	---	26 July
† <i>Scincella laterale</i> (Say)	4	390-463	25 Nov.	18 Apr.
† <i>Carpophis amoenus</i> (Say)	7	366-411	---	25 Apr.
<i>Coluber constrictor</i> Linnaeus	13 eggs	421	---	26 July
† <i>Lampropeltis triangulum</i> (Lacepede)	2	366-494	11 Nov.	18 Apr.
<i>Nerodia sipedon</i> (Linnaeus)	3	366-381	---	28 June
† <i>Tantilla coronata</i> Baird and Girard	1	445	---	18 Apr.
<i>Thamnophis sirtalis</i> (Linnaeus)	1	384	4 Nov.	---
<i>Agkistrodon contortrix</i> (Linnaeus)	1	410	---	8 Aug.
<i>Terrapene carolina</i> (Linnaeus)	5	381-445	8 Aug.	19 Apr.

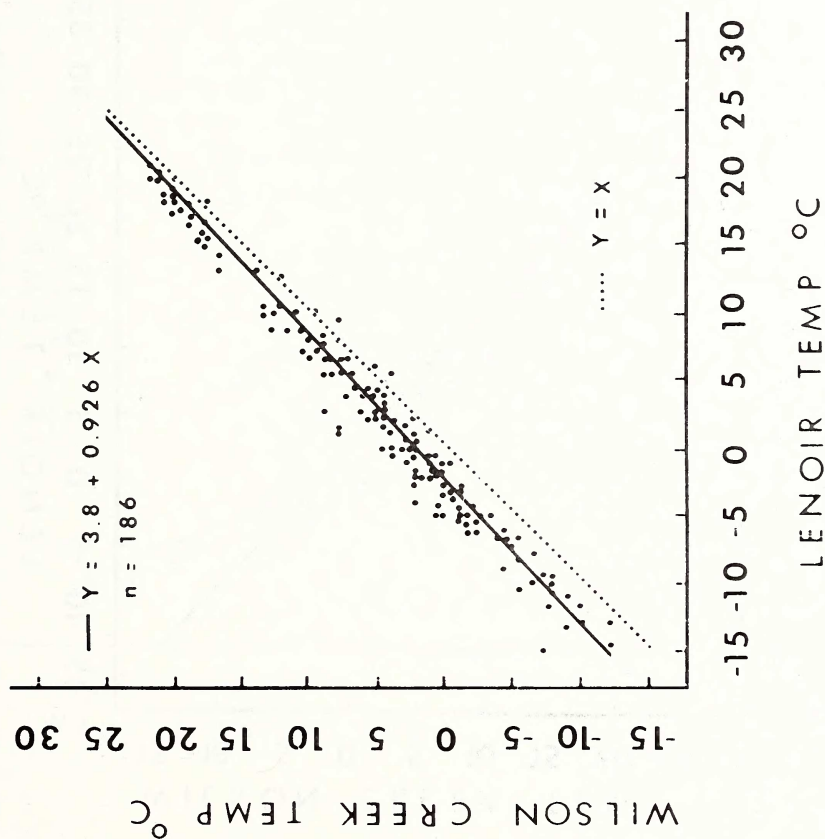


Fig. 1. Relationship between daily minimum temperatures at Wilson Creek and Lenoir. Includes most days between September 1, 1980 and March 15, 1981.

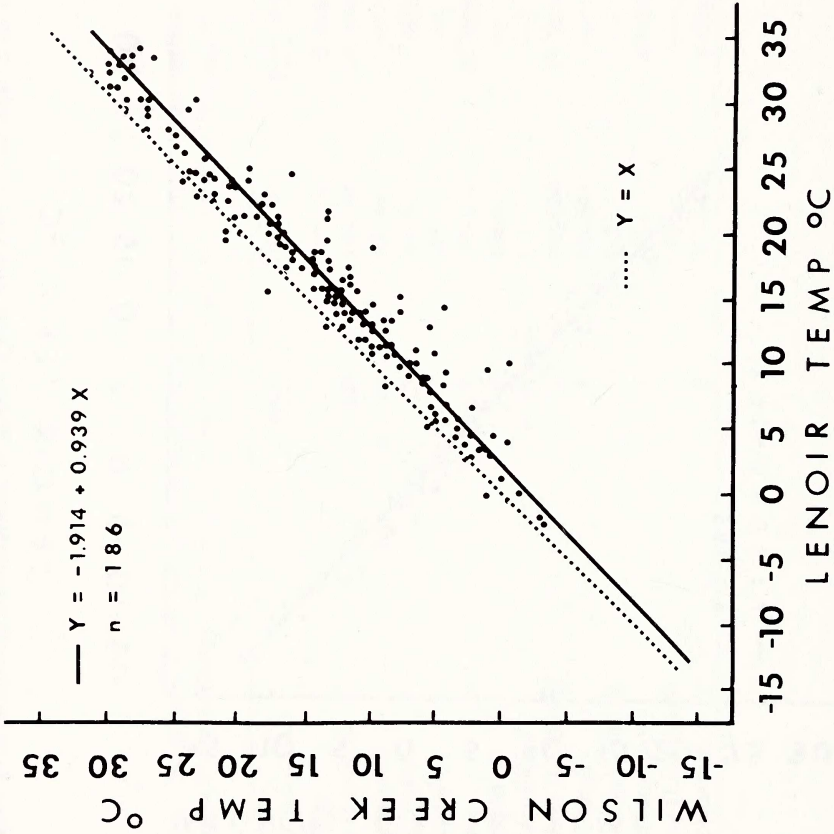


Fig. 2. Relationship between daily maximum temperatures at Wilson Creek and Lenoir. Data base as in figure 1.

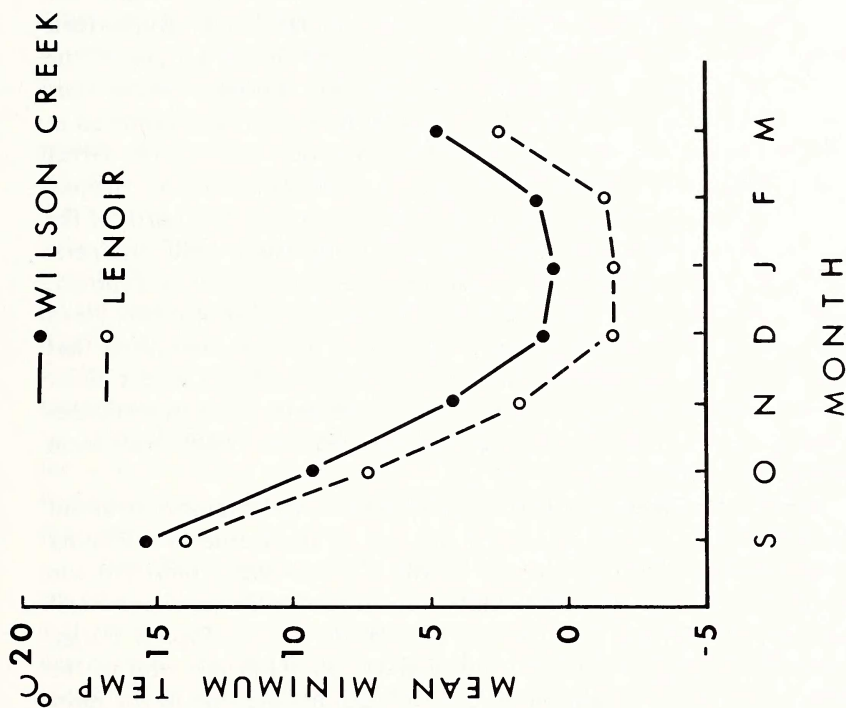


Fig. 3. Monthly means for daily minimum temperature at Lenoir and estimates for same means at Wilson Creek. Estimates based on regression on figure 1 and Lenoir data.

DISCUSSION

Four of Wilson Creek's reptiles represent significant range extensions into the northwestern mountains of North Carolina (Conant 1975; Martof et al. 1980; pers. comm., W. M. Palmer and A. L. Braswell) as discussed below.

Anolis carolinensis.— Anoles are common in the Coastal Plain of North Carolina almost to Virginia and are known from a couple of Piedmont Plateau and Mountain areas (Martof et al. 1980; pers. comm., Palmer and Braswell). There are only a few published records for this species in the mountains. Weller (1930) found them not uncommon at about 457 m (1500') near Chimney Rock, Rutherford County. Bruce (1965) found several individuals in the gorges of the southern Blue Ridge escarpment, Transylvania County, where they reached an altitude of 670 m (2200'). Anoles have also been reported at elevations below 550 m (1800') in the Tennessee part of the Great Smoky Mountains National Park (King 1939; Huheey and Stupka 1967). Another population near Townsend, Tennessee, just north of the Park, has been studied recently (Wade and Echternacht 1980, and pers. comm.). All montane sites for this species are associated with exposed, fractured rock with deep fissures, usually near the head of rather steep gorges. These conditions apparently ameliorate the cool conditions that exclude anoles from most of the mountains. The exposed rocks allow behavioral thermoregulation in the face of the cold, while the crevices provide a means to escape severe cold weather, for which they seem otherwise ill adapted (Mount 1975).

The Wilson Creek population represents a range extension of about 66 km (41 mi) north and 50 km (31 mi) east of the Rutherford County site, the closest published record. Wilson Creek is also about 161 km (100 mi) west of a Randolph County population in the northern Piedmont. The northernmost Tennessee population is near Pigeon Forge, which is about 48 km (30 mi) south and 170 km (105 mi) west of the Wilson Creek site. The anoles in Caldwell County are one of the most northern populations known, and are probably the population that experiences the most severe winter conditions encountered by the species.

Eumeces inexpectatus.— Southeastern five-lined skinks are not found in the higher mountains of North Carolina, even though they do extend to the north on either side of the mountains (Conant 1965; Martof et al. 1980; pers. comm., Palmer and Braswell). As with anoles, there are few records for this species in the mountains. Bruce (1965) reported them at elevations up to 550 m (1800') in the gorges along the southeastern escarpment of the Blue Ridge Mountains, Transylvania County. The species has been found infrequently in the Great Smoky Mountains National Park up to about 610 m (2000') (King 1939;

Huheey and Stupka 1967). Western Piedmont records from North Carolina are from Gaston, Randolph and Stokes counties (pers. comm., Palmer and Braswell). The Wilson Creek population apparently fills in a rather large hiatus between known populations. The site is about 225 km (140 mi) east-northeast of Swain County sites, 141 km (90 mi) north-east of Transylvania County records, 105 km (65 mi) north-northwest of Gaston County sites, 160 km (100 mi) west of Randolph County populations, and 140 km (85 mi) west-southwest of the Stokes County site. The closest Tennessee population is at least 160 km (100 mi) to the west. These lizards seemed to prefer rather xeric situations compared to other skinks at the site, as reported by Mount (1975) in Alabama and Minton (1972) in Indiana. Otherwise, there was little difference in the sites where this species and *Eumeces fasciatus* were found.

Scincella laterale.— Ground skinks are widely distributed in southeastern United States except at higher elevations (Conant 1965; Martof et al. 1980; pers. comm., Palmer and Braswell). Bruce (1965) found this species up to 945 m (3100') in southwestern North Carolina. It has been reported from the Great Smoky Mountains National Park up to about 793 m (2600') (King 1939; Huheey and Stupka 1967). Weller (1930) also found the species near Chimney Rock, Rutherford County, North Carolina. Several general works suggest that this species is relatively tolerant of dry, hot places (Mount 1975; Minton 1972), but it can apparently also live in some cooler, higher places.

The Wilson Creek site is about 40 km (25 mi) north-northeast of the closest record in McDowell County (pers. comm., Palmer and Braswell) and represents the most northern montane population yet reported.

Tantilla coronata.— The distribution of the southeastern crowned snake includes many areas in the Coastal Plain and Piedmont Plateau and several areas in the mountains (Conant 1975; Martof et al. 1980; pers. comm., Palmer and Braswell). The highest record for North Carolina is 428 m (1400') in Transylvania County (Bruce 1965). In the Great Smoky Mountains National Park this species has been recorded only on the Tennessee side at elevations up to 610 m (2000') (King 1939; Huheey and Stupka 1967). The Wilson Creek specimen extends the known range of this species in North Carolina 40 km (32 mi) north-northeast of a Burke County site and about 80 km (50 mi) west of an Alexander County locality. It also extends slightly the known elevational range in North Carolina.

Co-occurrence of four species in one area outside their previously known distributions argues fairly strongly that the populations are native to the site and brings up questions about why they persist at the site and when and how they arrived there. Their survival seems to be tied to the microenvironment of Wilson Creek gorge. Exposed rocks provide

abundant basking sites to overcome locally cooler daytime temperatures. Warmer evening and winter temperatures provide a relatively stable environment, and deep fissures permit escape from the occasional severe surface conditions. This combination of conditions probably occurs in other protected montane areas that could also support populations of these and/or other species that prefer warmer conditions.

Arrival of these species in the Wilson Creek area may be a relatively recent event or a more ancient one. Recent arrival would probably be the result of immigration by populations expanding up the Catawba and Johns rivers into the area. Since there is no other evidence for recent range expansions of native reptiles in the eastern United States, it is unlikely that this hypothesis is accurate. We consider these populations to be relicts and offer the following hypothesis about their origins.

During the last glacial maximum, about 18,000 years ago (yr BP), essentially all of the Coastal Plain of the Carolinas was occupied by a relatively Boreal forest of spruce and jack pines, indicative of a much cooler climate that excluded most southern plants and many southern animals (e.g. Watt 1979, 1980; Watt and Stuiver 1980; Flint 1971; Delcourt 1980; Wright 1976). The reptile species now characteristic of the Coastal Plain, including the four relicts at Wilson Creek, were found only much farther south. The warming trend that led to the retreat of the glaciers also resulted in the immigration of southern plants and animals into the Carolina Coastal Plain (Delcourt 1980; Webb 1981; Watts 1979, 1980; Watts and Stuiver 1980). The warming trend reached its climax in the Hypsithermal Interval when conditions were warmer and drier than they are today (Webb 1981; Wright 1976; Deevey and Flint 1957; Watts 1980; Watts and Stuiver 1980). In a few areas the Hypsithermal lasted until about 5000 yr BP (Delcourt 1980; Watts 1979) when the cooler, wetter climate of today was established.

By the end of the Hypsithermal, animals and plants should have spread throughout climatically suitable areas. Reptiles are somewhat limited by climate, so their distributions should have been more extensive at the end of the Hypsithermal than they are today. The cooling trend of the last 5000 to 7000 years should have resulted in local extinction of reptile populations as conditions became too severe, and in a general contraction of species' ranges to those seen today. Special local conditions, such as those of lower Wilson Creek or the gorges of the Southern Blue Ridge escarpment, could forestall local extinctions of reptiles by limiting the impact of the cooling trend (Billings and Anderson 1966; Anderson and Zander 1973; Bruce 1965). The result of this protection would be isolated, relict populations in refugia well separated from the main range of the species, as seen in the reptiles of lower Wilson Creek.

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